



PIER Energy-Related Environmental Research

Environmental Impacts of Energy Generation, Distribution and Use

Reproductive Timing of Freshwater Mussels and the Potential Impacts of Pulsed Flows on Reproductive Success

Contract #: 500-01-044

Contractor: University of California, Davis

Subcontractor: Spring Rivers Ecological Sciences, LLC

Contract Amount: \$171,000

Contractor Project Manager: Douglas Conklin

Commission Project Manager: Joe O'Hagan

Commission Contract Manager: Joe O'Hagan

The Issue

Native freshwater mussel populations in North America are declining at a catastrophic rate. The construction and operation of dams for hydroelectric generation, flood control, and navigation have contributed substantially to the drastic declines in mussel populations. Downstream of dams, unnatural pulses in stream discharge (i.e., pulsed flows) can reduce mussel reproductive success if the pulsed flows occur during critical periods in the mussel reproductive cycle. Knowledge of mussel reproductive timing in California river systems is scant, and this information is necessary for assessing the potential impacts of seasonal pulsed flows on mussel reproductive success and for scheduling these events to minimize reproductive interference.



Gonidea angulata gravid with developing embryos. With its shorter reproductive period, this species may be especially vulnerable to pulsed flows during June and July, its peak periods of glochidial release and juvenile excystment.

Project Description

This study's goal was to pinpoint time periods when mussel species in the Pit River drainage in northeastern California (Shasta County) would be most vulnerable to pulsed flows. Studied species included *Anodonta californiensis*, *A. nutalliana* (*wahlamatensis*), *Gonidea angulata*, and *Margaritifera falcata*. *Anodonta* were not identified to species because they are very difficult to distinguish in the field, and recent studies have emphasized the need for genetic analyses in identifying these species. To broaden the applicability of collected data, investigations were conducted in rivers and river reaches with different flow and/or temperature regimes.

The study's primary objective was to collect mussel reproductive data from three Pit River reaches that experience different manufactured flows and from two spring-dominated Pit River tributaries that have relatively stable flow regimes. Field investigations were conducted from April through November 2004 and from February 2005 through early May 2006. They focused on three critical reproductive events: spawning, glochidial release (when mature mussel larvae called glochidia are expelled to attach to suitable host fish), and juvenile excystment from the

host fish (i.e., when glochidia that have successfully transformed into juvenile mussels drop off of host fish).

To determine the timing of spawning and glochidial release, mussels were periodically collected and examined for incubating eggs or embryos, and samples of eggs/embryos were collected from the marsupia of gravid mussels to determine stages of development. In 2004, samples were also collected from the gonads of non-gravid mussels to determine their sex. In 2005–2006, stream drift was sampled downstream of undisturbed mussel assemblages to determine seasonal peaks in glochidial release.

To determine periods of juvenile mussel encystment (attachment) on host fish and estimate periods of juvenile excystment (detachment), fish were collected concurrently with mussels and examined for signs of glochidial infection. A portion of the infected fish collected during late March through September 2005 was transported to the laboratory and held in freshwater aquaria to determine the timing of juvenile excystment and the species of fish that acted as hosts.

PIER Program Objectives and Anticipated Benefits for California

This project offers numerous benefits and meets the following PIER program objective:

- **Providing environmentally sound and safe energy services and products.** The data in this report increase the knowledge base of native freshwater mussel biology and ecology. This research provides the groundwork for future monitoring and assessment of pulsed flows in the Pit River drainage, and for research of mussel reproductive timing in other regulated and unregulated rivers within California. Data from this and future studies on mussel reproductive timing will help managers of hydroelectric facilities, industry regulators, and policy makers assess the potential impacts of seasonal pulsed-flow releases on the reproduction of California mussel populations and help them to plan these flow events to minimize adverse effects on mussel reproduction.

Results

In the Pit River reaches, most adult mussels spawned and released glochidia from April through July, and most juvenile mussels dropped off of their fish hosts to settle on the stream bottom during June, July, and early August. Seasonal pulsed flows or maintenance outages that occur during these critical time periods would have a greater impact on mussel recruitment than those that occur after August. The shorter reproductive periods observed for *G. angulata* and *M. falcata* may make these species more vulnerable to pulsed flows than *Anodonta*, especially during peak periods of glochidial release and juvenile excystment/settlement. These peaks occurred for *G. angulata* during June and July in most locations.

Reproductive timing in *Anodonta* and *G. angulata* was similar in unregulated and regulated river reaches with different flow regimes. Reproductive timing in *M. falcata* varied between reaches, indicating that this species may be more sensitive to fluctuations in river flow and/or water temperature. Consequently, the annual timing and duration of *M. falcata* reproduction may be more difficult to predict in the Pit River and other California river systems.

The final report explains these results in far greater detail.

Final Report

The final report for this project can be downloaded from the Energy Commission's website at www.energy.ca.gov/2007publications/CEC-500-2007-097/CEC-500-2007-097.pdf.

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